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ABSTRACT

There is a crisis today in education, particularly in teacher-pupil relationships. The emotional climate of the typical elementary and secondary classroom must be changed, but without sacrificing progress by the children in the achievement of subject matter goals. However, with traditional classrooms, children need more feedback, praise, and attention than one teacher can provide. Computers offer a more responsive environment for learning; further, they can help teachers spend more of their time on human relations skills and less on rote, lower-order tasks for which they may not be prepared. Also, computers make genuine adaptive education for every learner possible in a way that no teacher alone can do and can greatly expand the available curriculum for learners. Thus, curricula need not be restricted by what is possible to teach: learners individually can have access to a wide variety of the world's knowledge and will be able to take more of the responsibility for what is learned. Realistically, estimating the costs of using computers will necessitate some new models for schooling which are explicit about educational goals and which capitalize on those new objectives that are made attainable by the application of computers in instruction. (RH)

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THE POTENTIAL CONTRIBUTION OF COMPUTERS TO INSTRUCTION REFORM

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The popular journals print numerous articles on the subject of the pervasive role of 53,000 extant computers in our society.[1] Many view with alarm the possibility that massive computer storage and retrieval capability can be employed to reduce man's privacy and prevent men from living down their earlier mistakes.[2,3,4] Some feel that the mere presence in our society of the computer which schedules airline seats, records bank deposits, adds up department store purchases, and routes long distance telephone calls also serves to dehumanize interpersonal relations and diminish the quality of life. The purpose of this paper is to show how computer technology should be viewed as a friendly giant rather than an evil genie and how it should be harnessed to provide the catalyst for badly needed reform in the education of Americans.

In order to restrict the paper's scope, I will only deal with the computer's potential in instruction and omit the familiar administrative and student accounting computer applications which are, of course, a part of the total education scene.

The existence of a number of well written critiques,[5,6,7] whose conclusions are supported by facts reported in almost any issue of a big city newspaper, makes it unnecessary to document in detail the idea that there is a crisis in schooling at the beginning of the 1970's. There is a crisis in confidence between the lay public and educators and between education workers and boards of control. There is a crisis in financing schools as school costs rise more rapidly than tax revenues. There is a crisis in achievement as many children come up to age and grade guideposts unable to meet minimal literacy standards. I believe a root cause of many of these crises lies in the badly deteriorated relationships between teachers and pupils in classrooms. Further, reform in instruction can, and indeed must, pave the way for ameliorating many of the other tensions related to the education of Americans.

The crisis in teacher-pupil relationships is borne out by the school statistics on excessive absences, vandalism, drug abuse, riots, violent attacks on authority figures, and even murder of a teacher as recently happened in Philadelphia. No doubt there are multiple causative factors which explain these asocial behaviors, but underlying all of them is the elementary notion that most children do not like school. At worst, school is perceived as a primitive, spirit-destroying place which fills no essential need in children's lives. Most teachers and administrators are viewed as adults who holler at the kids, and as persons who enforce petty rules and wield arbitrary power. A kind of adversary system dominates the classroom interaction of most schools in which the teacher and his backup reserves, the principal and guidance counselor, are pitted against the pupils. While destructive interpersonal games are played out in the typical school, the rest of society stands on the sidelines wringing its collective hands.

One of the first things we must do to reform schools is to markedly increase the manifest expression of human warmth between adults and children. Essentially the challenge is how to change the emotional climate of the typical elementary and secondary classroom without sacrificing progress by the children in the achievement of subject matter goals. All youngsters must be able individually to get rewards and praise for their honest attempts to learn. To provide children with massive doses of praise and other indications of their self-worth, we have to arrange for a much much higher level of feedback or effort evaluation than is characteristic of the typical classroom which provides a cage for 25-30 children, one teacher, and a variety of inert materials. Careful studies of classroom behavior[8] show that most lessons above the primary levels are conducted as either an expository lecture or a class discussion on some topic; or, in other words, class activities consist of telling and recitation. Individual pupils have, under typical conditions, only minimal opportunities to directly interact with the teacher who must somehow instruct 30 children as if they were only one.

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1. Computers and Automation, Monthly Computer Census, *20*, pp. 59-61, Jan. 1971.
2. Alexander, T. Computers Can't Solve Everything. *Fortune,* Oct. 1969, *LXXX*, 126-129.
3. White, P.T. Behold the Computer Revolution. *National Geographic,* Nov. 1970, *138,* 593-633.
4. Computers Are Changing Your Life. *U.S. News & World Report,* Nov. 10, 1969, 71, 100-103.
5. Holt, J.C. *How Children Fail.* New York: Pitman, 1964.
6. Kozol, J. *Death at an Early Age.* Boston: Houghton Mifflin, 1967.
7. Silberman, C. *Crisis in the Classroom.* New York: Random House, 1970.
8. Reviewed in Medley, D. and Mitzel, H. "Measuring Classroom Behavior by Systematic Observation," pp. 247-328 *in* Gage, N. (Ed.) *"Handbook of Research on Teaching,"* Chicago, Rand McNally, 1963.

In a previous article[9] I have shown how the aggressive able youngster in a class discussion may recite and receive feedback, including praise 4 or 5 times during a 40-minute class period. A shy, withdrawn child is easily overlooked and unnoticed, and may recite with expressions of teacher approval only once a week. Contrast that mass-education picture with the computer-assisted instruction work room where every child receives feedback and encouragement of his learning efforts once every 30 seconds on the average for a total of 80 different rewarding and informative exchanges in a 40-minute period at the computer terminal.

With sensitive programing computer terminals create for school children an absorbing responsive environment for learning. The child knows that when he makes a response something will happen immediately to provide him with an appraisal of the quality of his response and offer him guidance toward his future efforts. There is little wonder that 450 ninth-graders in a Pittsburgh high school,[10] who spend a portion of their daily mathematics lesson at the computer terminal and a portion in individualized study with print media, markedly prefer the computer experience.

So far we have discussed the superiority of the computer terminal over conventional mass instruction in creating a responsive environment associated with typical learning activities. But, there is an additional opportunity for greatly improving the quality of school climate when computer tutorials are introduced into schools.

To understand this second opportunity we can classify teacher's skills in the classroom as being of higher order and lower order. Examples of lower order skills can be suggested as presentation of information to be learned, display of drill and practice exercises, evaluation of pupil responses and provision of feedback. Some examples of higher order skills are diagnosis of a child's learning disability, mediating a dispute, assessing the impact of a pupil's home environment upon his in-school behavior and expressing comfort for a wounded spirit or an injured body. The cause of instruction reform would be greatly advanced if the lower order skills as defined above were largely put into carefully sequenced computer programs. The savings in time for teachers by removing the necessity for them to engage in lower order skills would enable them to transfer their uniquely human talents to the higher order skills for which there is no computer programing in the foreseeable future. Of course, many teachers would have to be retrained in order to shift their emphasis from lower order skills to the higher order ones.

Silberman[11] documents the great interest being expressed by American educators in the British Infant School model. By minimizing structure and emphasizing pupil freedom to inquire and explore, these schools are unquestionably improving school-going attitudes on the part of youngsters. Many Americans will, however, be unable to accept the absence of the traditional lesson plan with its interest-arousal activities, presentation, exhortation, and followup by the teacher, all of which "turn off" most children in today's schools.

Since the close of World War II, about two and a half decades ago, Americans have been trying to improve their schools by increasing the subject matter knowledge of classroom teachers. Federally sponsored institutes since the passage of the National Defense Education Act of 1958 have made it possible for a significant segment of the Nation's secondary teachers to be upgraded in their knowledge of a subject. The rationale for this new interest in inservice teacher education was, of course, the notion that a teacher cannot teach well those subjects which he does not himself know well.

It seems to me that the heavy emphasis placed on pupil acquisition of hard content, characteristic of the postsputnik era, has been bought at the price of a declining interest and concern among educators for the human values which should be a part of schooling. This is not to say that educators ought to be less achievement-oriented than they are now, but that we have to recognize that the total complex job of teaching in a contemporary school makes impossible demands upon the talents of the more than 2 million persons on the teacher corps. Relatively few, perhaps only one in a thousand, possesses sufficient native ability to engage simultaneously in both lower order and higher order teaching behaviors in the conventional mass education classroom. If we shifted a major portion of the lower order presentational skills to a rich computer-assisted instruction environment and then retrained our typical teachers to engage in and emphasize higher order human relations skills in the classroom we could in a decade perhaps reform the bulk of the education of Americans.

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9. Mitzel, H. "The Impending Instruction Revolution," *Phi Delta Kappan,* Vol. LI, 8, pp. 434-439, 1970.
10. Mitzel, H. and Bost, W. in Morphet, E. and Jesser, D. (Eds.) "Designing Education for the Future," Denver, The Project Office, 372 pp., 1968.
11. Silberman, C., op. cit.

It is a paradox that computers, epitome of impersonality and product of the space age, offer us an opportunity to reform our schools by making it possible for teachers to redirect their efforts and to humanize schooling.

So far we have argued in this paper that instruction as a major segment of American elementary and secondary education can be reformed by introducing appropriately programed computer interactive opportunities for children. This reform can occur for two reasons: (1) Youngsters working at computer terminals experience a unique responsive environment which builds their self-confidence and feelings of self-worth; (2) teachers can, when freed from lower order expository tasks, engage in supportive higher order behaviors that are uniquely humanizing for children.

In addition to the two reasons cited above for incorporating computer technology into instruction, the computer makes "thinkable" for the first time in history, the notion of a genuine adaptive education for every learner.[12] The idea of individualizing instruction has been given consideration in every decade of this century. Its implementation has, of course, fallen far short of the goal because of the unavailability of instructional systems which can receive, process, and display large amounts of relevant data about individuals. Tyler[13] has shown that the concept of individualized instruction has been arrested at the simplex level of learner self-pacing. The programed text and teaching machine developments of the 1955-65 era contributed mightily to the self-pacing notion. These applications, however, ignored the rich diversity of individual differences among learners and failed to capture the essential notion that instruction needs to be adapted to the particular skills, abilities, and interests of learners who vary tremendously.

The logic and preprogramed decisionmaking capabilities of the modern digital computer make it the only candidate immediately in view that can handle the complex task of monitoring, summarizing, diagnosing and prescribing instructional moves for many learners. Of course, educators do not yet know in any detail which of the hundreds of descriptive variables about learners are relevant for instruction. But this needed evidence represents an empirical question which can be derived from the experience of programing courses of instruction for computer presentation and trying them out on learners with many hypotheses about different learner-adaptive variables.

Almost everyone these days who is weighing the potential of the computer for education in the next three decades seems to be viewing computers as mere replacement mechanisms for contemporary procedures, personnel, and learning activities. I believe the nature of this powerful logic and decision device makes it incumbent upon us to re-examine our educational goals for all learners. The computer makes it possible for educators to greatly expand the available curriculum for learners. The knowledge retrieval capability of large computer systems plus the storage and use of adaptive information about learners will make it possible for every learner to have a unique curriculum. No longer will debates about curriculum be restricted by what can comfortably be taught to an average group of youngsters at a particular grade level. The computer as a tool makes it possible for learners individually to have access to a wide variety of the world's knowledge. Instead of the long debates about what is worth teaching, educators will be able to shift this responsibility in large part to the learner himself.

We have for a long time recognized the motivating effects of self-direction or independent study. If instruction can be, to a large measure, put into computer storage, and learners given a wide variety of choices in deciding what they want to learn and in what sequence, then the education enterprise will be blessed with increased motivation and improved learner self-direction. Of course, these applications of the computer in removing the shackles on education cannot be expected by the end of this decade, but we can have them much sooner than many people realize because they depend on no new technological developments or no new pedagogical concepts. The major restraints lie within the social institutions responsible for education.

Speaking of restraints on education brings one inevitably to the question of costs for triggering the reform of instruction with computers. Most of the available cost studies[14] either view computers as an add-on expense or as a replacement for existing teacher services. Neither seems to me to be an appropriate assumption. Cost studies

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12. Mitzel, H., "Computers and Adaptive Education," *American Education*, pp. 23-26, December 1970.
13. Tyler, R., "New Directions in Individualizing Instruction," in the Abington Conference of 1967, Abington, Pa.: The Conference, 1967.
14. Silberman, C., op. cit.

also start with the notion that "instant CAI" in 20,000 school districts is both desirable and possible. The automobile has revolutionized the transportation of Americans, but nobody suggested that it was necessary in 1910 to have 80 million vehicles and a $40 billion interstate highway network. The development and improvement of automobiles over the years increased the demand for better roads, better services stations, better insurance, et cetera. The same phenomenon can be anticipated with the installation of computers in schools. If there is a significant beginning, there will be a demand for better curriculum packages, better maintenance service, and better hardware. Some venturesome schools will have to begin the implementation cycle even though the hardware is inadequate and the curriculum for the computer is spotty in its coverage. It will take these schools with a pioneering spirit to create a "market" for improved devices and instruction, whether these materials are produced commercially or by consortiums of public enterprises.

Cost studies[15] [16] [17] now available seriously underestimate the necessary impact of computer instruction applications upon the structure and organization of the school. There is every reason to believe that with a major program of computer use, schools will change their staffing patterns and building requirements. My guess is that CAI schools will need many fewer $15,000-per-year teachers and more $25,000- and $7,500-per-year personnel. CAI schools will be organized into small 100-200 pupil units even at the secondary level, with a considerably lessened demand for librarians, guidance counselors, remedial reading teachers, et cetera, although these lowered requirements will be offset to some extent by personnel needs in computer technology. Comprehensiveness, which provided the major rationale for today's giant urban high schools, can be met in part by a variety of individualized computer-based courses of instruction in small intimate decentralized units. Computers seriously applied to educational programs will change the building patterns and revise costs. For example, if high schools were smaller and nearer to pupils homes, would we still have to build, furnish and staff cafeterias? Perhaps the single major cost saving with a computer-based program is the change from teacher-directed, adult-controlled pupils to self-directed and self-monitored pupils. No one doubts the desirability of the latter and its capability of offsetting some of the costs inherent in the incorporation of computers into instruction.

In short, it is probably futile to attempt to project the costs of incorporating computers into instruction given the present model provided by contemporary schools. To make sense out of costs, we will need some new models for schooling which are explicit about educational goals and which capitalize upon those new objectives that are made attainable, in theory at least, by the application of computers to instruction.

Estimating the costs of using computers to lead the reformation of instruction is tricky business. Current cost estimates seem high because of the retention of some hidden assumptions about the present structure and organization of the schools.

In summary, the thesis of this paper is that reform in the education of Americans is badly needed. Central to that reform is an improvement in the social climate of schools and the interaction between pupils and adults. Paradoxically, computers can make a significant contribution to the humanizing of the schools by taking over many of the lower order expository skills from teachers' present repertoires and releasing them to become, with retraining, warm human beings sensitive to the personal needs of children. The computer can help improve the climate of classrooms by providing immediate ego-building feedback and encouragement for learners' efforts. The third plus for the computer in instruction reform is its potential in realizing a genuine adaptive education for every learner. So far the notion of adaptive education has been pretty well arrested at the level of learner self-pacing, but the computer's capability of dynamically modifying every learner's instruction on the basis of many different relevant variables opens up new opportunities for education. Fourth, the computer encourages the establishment of new individualized goals for education by making it possible for learners to exercise many choices and options in guiding their own development. Opening up the world of knowledge to learners who have the tools to make choices cannot help but exert a liberalizing influence on education.

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15. Booz, Allen and Hamilton. "Costs of Installing and Operating Instructional Television and Computer Assisted Instruction in the Public Schools." Booz, Allen and Hamilton, Management Consultants, New York, 1968.
16. Committee for Economic Development, Innovation in Education: New Directions for the American School, Statement by the Research and Policy Committee, July 1968.
17. Kopstein, F.F. and Seidel, R.J., "Computer Administered Instruction Versus Traditionally Administered Instruction: Economics." Professional Paper 31-67, Human Resources Research Office, The George Washington University, June 1967.